Experimental signature of Stop production at the LHC

We have found a new particle!

To BEH or not to BEH?

- 4th July 2012: world-wide announcement by CERN of the observation of a new particle
- observed by both the ATLAS and CMS collaborations
- preliminary results compatible with the observation of the long-sought boson

\[ \text{M}_{\text{Higgs}} = (125.8 \pm 0.5 \text{(stat.)} \pm 0.2 \text{(syst.)}) \text{ GeV} \]

Shortcoming of the SM: SuSy to the rescue

SUSy is broken: STOP!

No observation of SuSy particles so far...

- SuSy must be broken at the SM energy scale and masses of SuSy particles are around (or beyond) the TeV-scale!
- 3rd gen. squarks usually much lighter than other squarks
- current results from BEH searches favour a rather light SuSy partner of the top quark

[MS question: are stops light enough for the LHC?]

Experimental signature of Stop production at the LHC

R-parity conservation:
- pair production of sparticles
- decay chains ending with lightest SuSy particle (LSP)

Possible Stop quark production mode at LHC:
- direct pair production: \( p\bar{p} \rightarrow t\bar{t} \)
- gluino cascade decay: \( p\bar{p} \rightarrow g\bar{g} \rightarrow t\bar{t} \)

A challenging signature:
If \( |\Delta m| \sim m_t - m_\text{top} \), the signal is very top quark-like and therefore very difficult to extract from the overwhelming top quark pair background. Might explain why no signal has been observed so far...

The Compact Muon Solenoid (CMS) detector

Signal events:
- Minimal SuSy Standard Model (MSSM)
- parameterization: \( (m_\text{top}, m_1)^2 \)
- 16 signal points
- 4 lines with equal \( \Delta m \)

Search strategy

Targeted topology:
- Minimal SuSy Standard Model (MSSM)
- parameterization: \( (m_\text{top}, m_1)^2 \)
- 16 signal points
- 4 lines with equal \( \Delta m \)

1. Baseline selection:
- trigger: one lepton and three jets
- exactly one isolated lepton (\( p_T > 20 \text{ GeV}/c \))
- at least four reconstructed jets (\( p_T > 30 \text{ GeV}/c \))

2. Background estimation:
- fully data-driven
- exploit the observed b-tagged jet multiplicity
- discriminate the various background processes
- precision: at the \% level!!

3. Advanced event selection using a neural network (NN):
- training optimised for each \( \Delta m \) line
- 5 selected variables among the most discriminating ones
- jet, MET, M_{T}(MET), n. of jets, M_{Dj}
- figure of merit: expected upper limit on \( m_{\text{top}} \)
- selection efficiency derived from simulation and applied to the background estimations:
- reduced dependency on simulation, reduced systematic uncertainties!
- make the best use of the accuracy of the background estimations

A challenging signature:
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Results

A collaborative work:
- University of Ghent
- L.L.P. (Lisbon)

Results:
- No excess over SM expectations in 2011 7 TeV data (5 fb\(^{-1}\))
- Upper limits on stop pair production cross-section in the context of the MSSM competitive with results from ATLAS
- Results under current review by the CMS Collaboration
- 2012 8 TeV data: \( \sim 20 \text{ fb}^{-1} \)....Ongoing analysis. Stay tuned!

Upper limit at 95% C.L. on stop pair production cross-section at 7 TeV:

- CMS Preliminary: 5 fb\(^{-1}\) at 7 TeV
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Search for Supersymmetry with the CMS detector at CERN-LHC

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